(12) UK Patent Application (19) GB (11) 2 100 069 A

(21) Application No 8212030
(22) Date of filing
26 Apr 1982
(30) Priority data
(31) 8114211
(32) 8 May 1981
(33) United Kingdom (GB)
(43) Application published
15 Dec 1982
(51) INT CL³ H01F 23/00
(52) Domestic classification
H1T 12 1F 6 7C4
H4R 10AX 10C1 TC
(56) Documents cited
None
(58) Field of search
H1T
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(54) Improvements in or relating to electric couplings

(57) An inductive electric coupling in the form of a three phase transformer is provided by three bus bars 26, 27, 28 in parallel relationship joined together at a star connection 29 at one end and to a three phase electric supply at the other end. The bus bars 26, 27, 28 extend through respective windows 19 of an iron core 18, and secondary windings 22 are distributed about the core 18. The core 18 and the secondary windings 22 are carried by a mobile carriage 10 arranged to be driven on a track 11 parallel to the bus bars 26, 27, 28 by an electric motor 32 which is energised by the electric current induced in the secondary windings 22. The induced electric current may also be used to energise a hoist or a master slave manipulator mounted on the mobile carriage 10.

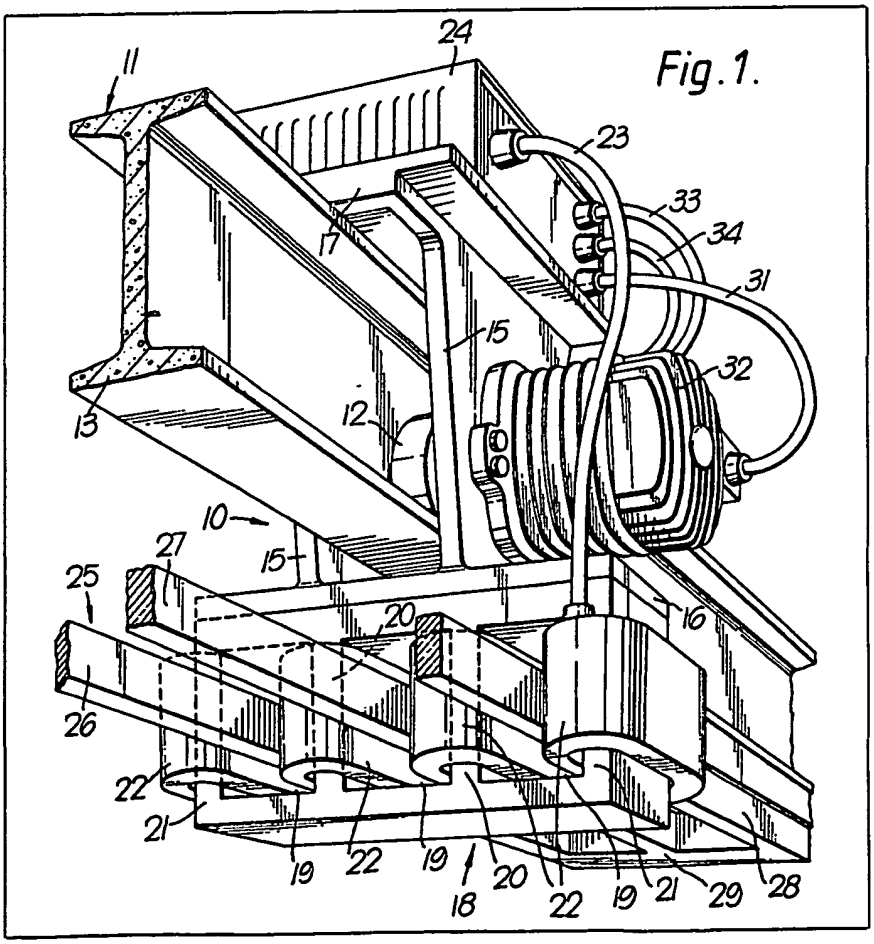

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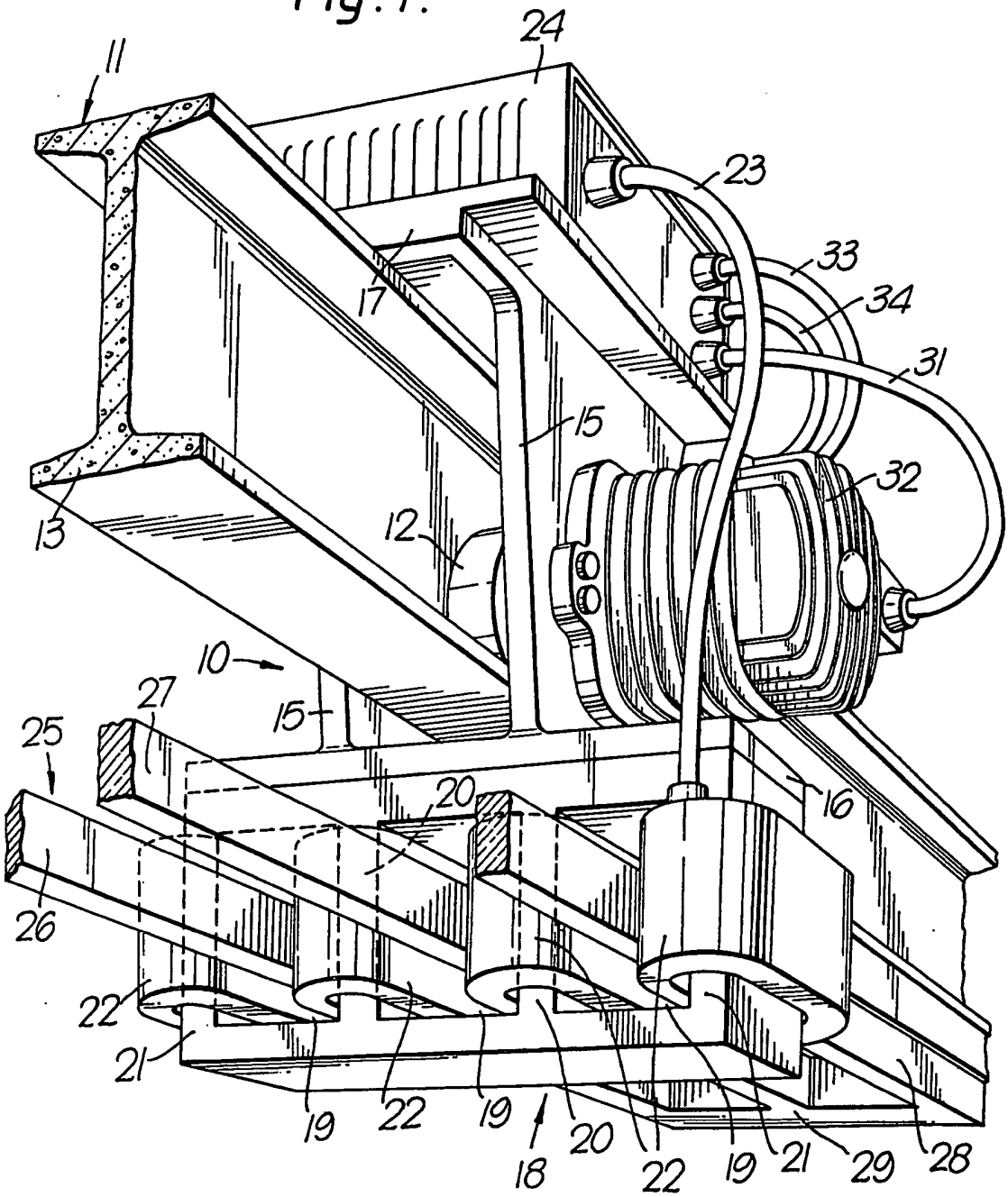
Fig. 1.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21
29
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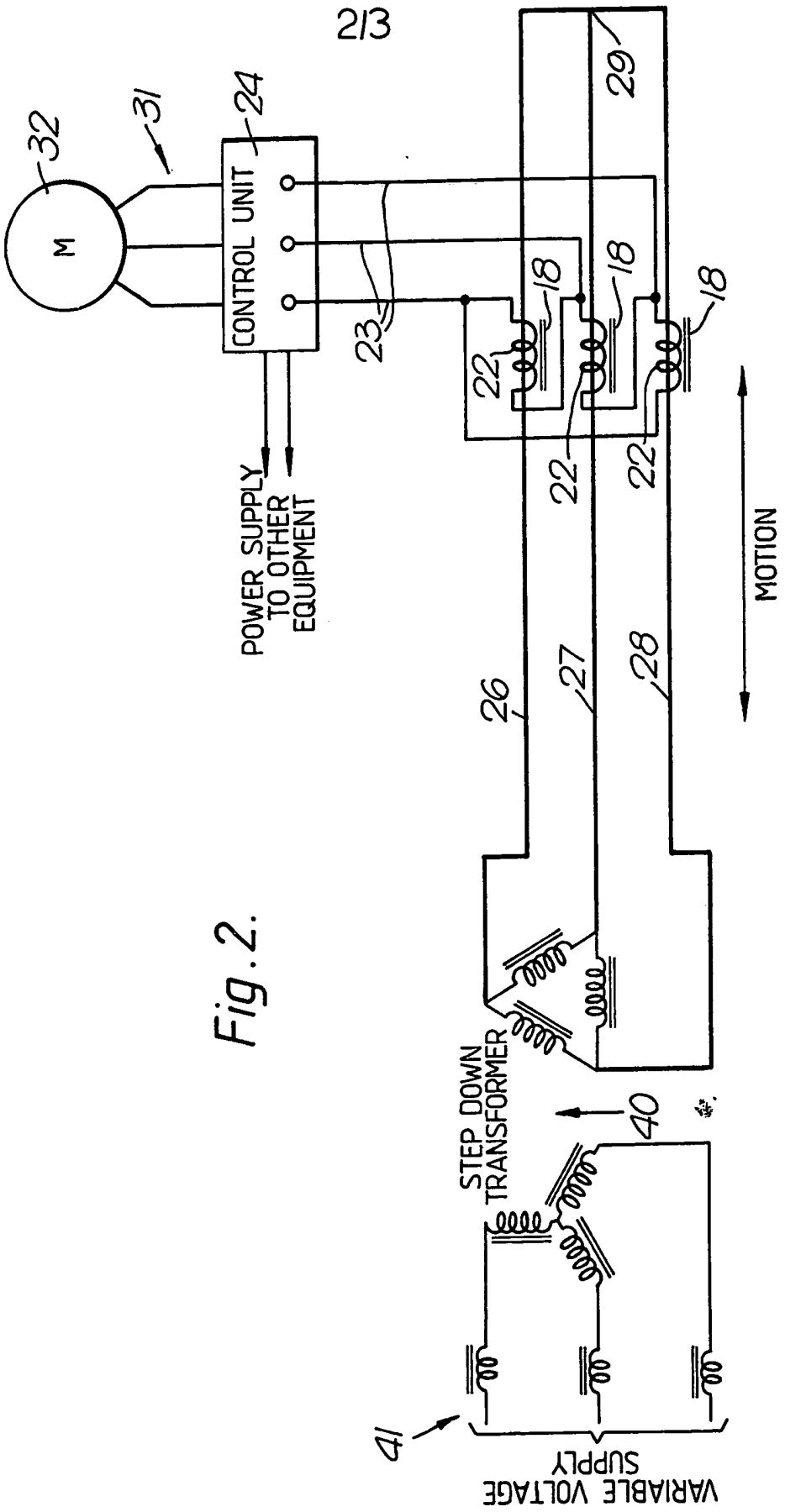
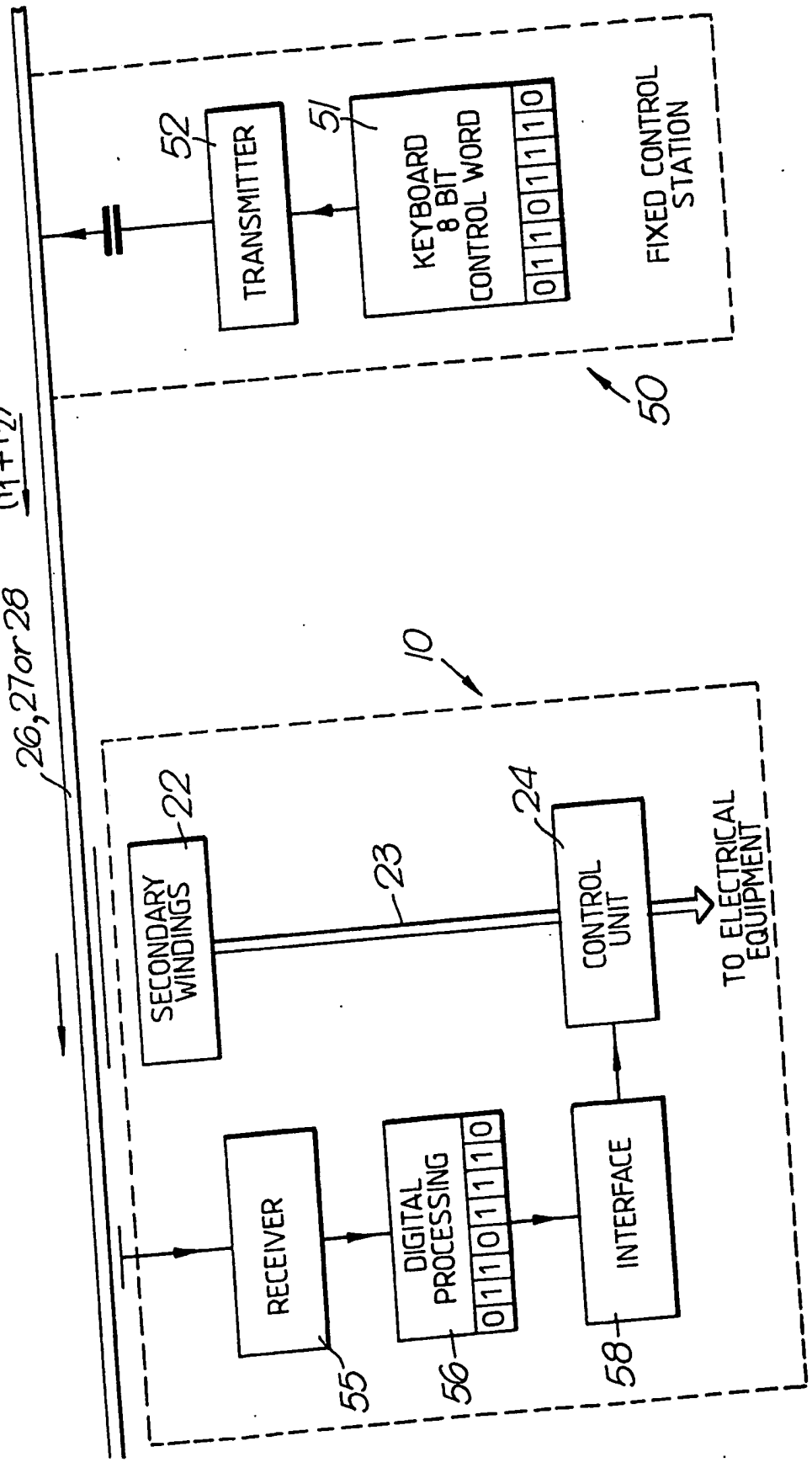

213
29
32
31
24
M
CONTROL UNIT
23
18
18
18
22
22
22
POWER SUPPLY
TO OTHER
EQUIPMENT
MOTION
26
27
28
STEP DOWN
TRANSFORMER
40
41
VARIABLE VOLTAGE
SUPPLY

Fig. 2.

Fig.3.


26,27or28
(f1+f2)
50
FIXED CONTROL STATION
51
KEYBOARD 8 BIT CONTROL WORD
0 1 1 0 1 1 1 0
52
TRANSMITTER
10
22
SECONDARY WINDINGS
23
24
CONTROL UNIT
TO ELECTRICAL EQUIPMENT
RECEIVER
55
DIGITAL PROCESSING
0 1 1 0 1 1 1 0
56
INTERFACE
58

SPECIFICATION

Improvements in or relating to electric couplings

This invention relates to electric couplings, and more particularly to electric couplings used to connect a movable electric device to an electric supply.

Known arrangements for supplying power to movable electric devices include cable links which may become twisted or tangled if the device is moved randomly, and wiping contacts which may become contaminated in the environment with a material that makes reliable electrical contact difficult.

According to one aspect of the present invention, there is provided an inductive electric coupling comprising, a multiphase transformer having at least three phases and having the primary and the secondary windings thereof movable relative to each other, each of the secondary windings being movable along a locus at a magnetic flux density of substantially constant root mean square value by drive means arranged to be energised by the secondary windings.

According to another aspect of the present invention, there is provided an inductive electric coupling comprising a multiphase transformer having at least three phases and having the secondary windings thereof movable relative to the primary windings thereof along a locus at a substantially constant distance from the primary windings for at least a portion of the primary windings; a carriage supporting the secondary windings and movable in a manner to move the secondary windings along said locus; and drive means arranged to be energised by the secondary windings and supported by the carriage for moving the carriage and thereby the secondary windings.

The said portion of the primary windings may comprise three parallel elongate sections of the primary windings of a three phase transformer, and the elongate sections may be joined together at one end in a star connection.

Preferably, the inductive coupling includes a magnetizable core for the secondary windings, the core being movable with the secondary windings.

Desirably, the coupling also includes a control system for controlling the drive means, the control system comprising a transmitter, a receiver for signals from the transmitter and movable with the secondary windings, and a processing means for controlling the drive means from the signals received by the receiver. At least some of the signals may be transmitted through one of the primary windings.

The invention also includes a primary winding for an inductive electric coupling, the winding comprising three elongate parallel conductors joined together in a star connection at one end and connectable to a three phase alternating current electric supply at the other end.

The invention has one application for coupling a three phase alternating current electric motor to a three phase alternating current supply, there being provided means arranged to be driven by the electric motor for moving the secondary windings relative to the primary windings.

The invention will now be further described by way of example only with reference to the accompanying drawings, in which:—

Figure 1 shows a perspective representation of a mobile carriage powered by an inductive electric coupling;

Figure 2 shows a circuit schematic diagram of the inductive electric coupling of Fig. 1; and

Figure 3 shows a communications link system for controlling the mobile carriage of Fig. 1.

Referring now to Fig. 1, a mobile carriage 10 is shown about an I-section beam 11, and is supported on the beam 11 by two pairs of metal wheels 12 in tandem (only one wheel 12 is shown), a pair of the wheels 12 being at each side of the beam 11 and arranged to run on a lower flange 13 of the beam 11. The carriage 10 has a vertical tie portion 15 at each side of the beam 11 to which the wheels 12 are rotatably located, the tie portions 15 being joined at the lower ends thereof to a cross-piece 16 and depend at the upper ends thereof from a platform 17. The cross-piece 16 supports a magnetizable iron core 18 of rectilinear shape and has three windows 19 defined by two inner vertical members 20 and two outer vertical members 21 of the core 18.

Three secondary windings 22 each comprising a plurality of continuous cable turns (not shown), are disposed around the magnetizable iron core 18, and are each connected by a lead 23 (only one is shown) to a control unit 24. Two such windings 22 comprise the turns around the two inner vertical members 20 respectively, and the turns around the outer members 21, joined in series, form the third winding 22.

A three phase primary winding 25 in the form of three copper or aluminium bus-bars 26, 27 and 28 respectively in parallel relationship are joined in a star-connection 29 at one end and extend through respective windows 19 in the core 18. A lead 31 from the control unit 24 is connected to a three phase electric motor 32 which is connected by a gear drive (not shown) to one pair of the wheels 12 so as to drive the carriage 10 along the beam 11 when the electric motor 32 is energised, the other pair of wheels 12 being free-running. Supply leads 33, 34 from the control unit 24 may be connected to other electrically powered equipment, for example

an electric hoist (not shown) and/or a master slave manipulator (not shown).

Referring now to Fig. 2, the bus-bars 26, 27, 28 are shown connected to a step-down three phase transformer 40 which is energised from a three phase variable voltage supply 41.

In operation, when a three phase alternating electric current is supplied to the step-down transformer 40, and thus to the bus-bars 26, 27, 28, an alternating magnetic flux is set up in the core 18 which induces an electrical current in the secondary windings 22. The secondary windings 22 supply an induced three phase current via the control unit 24 to the electric motor 32 which drives the gear train and thus the respective pair of wheels 12 to drive the carriage 10 along the beam 11 as shown by the arrows.

In order to control the control unit 24, and thus individual equipments to which it is connected, a capacitive pick-up communications link may be used as shown in Fig. 3 to which reference is made. In Fig. 3 a fixed control station 50 is arranged to transmit a digital control word serially through one of the bus-bars 26, 27, 28, using frequency shift keying techniques in which a digital '1' is represented by one frequency (fl) and a digital '0' by another frequency (f2), (f1) and (f2) being in the region of 1MHz. The fixed control station 50 comprises a key board 8 bit control word 51 connected to a capacitive transmitter 52. At the carriage 10, the control words transmitted by the bus-bars 26, 27 or 28, are detected by a capacitive receiver 55 to convert the frequency signals (f1), (f2) to voltage levels representing 1's and 0's which are passed to a digital processing unit 56 to produce the complete control word. The control word is passed to an interface circuit 58 connected to the control unit 24 and thus controls the application of the electric power induced in the secondary windings 22.

Of the 8 bit control word, two bits are used for error detection, and the data flows from the fixed control station 50 to the carriage 10, although if desired a two-way data system could be used and the word length extended.

The communications link described in relation to Fig. 3 "falls safe" in that all applications of electric power controlled by the control unit 24 are terminated in the event of:—

(a) the output of the receiver 55 being low or,

(b) the digital word being corrupted or,

(c) drift occurring in the frequencies transmitted.

It will be understood that instead of the communications link of Fig. 3, an alternative link such as a radio link may be used; and the bus-bars 26, 27, 28 may be straight or of alternative shape, for example of arcuate shape for applications in which the carriage 10 is required to follow an arcuate path, and need not be coplanar.

The invention may be incorporated in alternative multi-phase transformers, for example, having six phases.

Similar inductive coupling arrangements may also be made with single or two phase transformers.

CLAIMS

1. An inductive electric coupling comprising, a multiphase transformer having at least three phases and having the primary and the secondary windings thereof movable relative to each other, each of the secondary windings being movable along a locus at a magnetic flux density of substantially constant root mean square value by drive means arranged to be energised by the secondary windings.

2. An inductive electric coupling comprising, a multiphase transformer having at least three phases and having the secondary windings thereof movable relative to the primary windings thereof along a locus at a substantially constant distance from the primary windings for at least a portion of the primary windings; a carriage supporting the secondary windings and movable in a manner to move the secondary windings along said locus; and drive means arranged to be energised by the secondary windings and supported by the carriage for moving the carriage and thereby the secondary windings.

3. A coupling as claimed in Claim 2, wherein said portion of the primary windings comprises three parallel elongate sections of the primary windings of a three phase transformer.

4. A coupling as claimed in Claim 3, wherein the elongate sections are joined together at one end in a star connections.

5. A coupling as claimed in any one of the preceding claims, including a magnetizable core for the secondary windings, the core being movable with the secondary windings.

6. A coupling as claimed in any one of the preceding claims and including a control system for controlling the drive means, the control system comprising a transmitter, a receiver for signals from the transmitter and movable with the secondary windings, and a processing means for controlling the drive means from the signals received by the receiver.

7. A coupling as claimed in Claim 6, wherein the transmitter is arranged to transmit signals at different frequencies, the signals representing digital control words.

8. A coupling as claimed in Claim 6 or Claim 7, wherein at least some of the signals are transmitted through one of the primary windings.

9. A coupling as claimed in Claim 6 in combination with an electric hoist adapted to be supported with and arranged to be energised by the secondary windings, and in

which the hoist is controlled by the control system.

10. A coupling as claimed in Claim 6 in combination with a master slave manipulator adapted to be supported with and arranged to be energised by the secondary windings, and in which the master slave manipulator is controlled by the control system.

11. For an electrical coupling as claimed in any one of the preceding claims, a primary winding comprising three elongate parallel conductors joined together in a star connection at one end, and connectable to a three phase alternating current electric supply at the other end.

12. An inductive electric coupling substantially as hereinbefore described and with reference to Figs. 1 to 3 of the accompanying drawings.

Printed for Her Majesty's Stationery Office
by Burgess & Son (Abingdon) Ltd.—1982.
Published at The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.